CLAIMS

1. A method for recovering high quality steel and non-ferrous metals from contaminated steel scrap by in-line continuous processing of liquid scrap without the disruptive influence of sub-surface nucleation and growth of carbon monoxide bubbles, a characteristic of steel melts containing dissolved oxygen and carbon, which also avoids high vacuum evaporative distillation but rather employs straightforward physical desorption into an inert strip gas at reduced pressure by ensuring that the carbon/oxygen reaction is under control or its effects unable to disrupt the functionality of barometric legs for continuously transporting molten steel product from reduced pressure vessels or desorbers back to around atmospheric pressure into low level back-mixed liquid sumps by recirculating melt between the basal region of such vessels and these sumps using an adaptation of established RH vacuum degassing practice employing an upleg and a downleg for melt circulation at a rate many times that of the steel product rate and at least in the region of 20 tonnes per minute in conjunction with product metal removal from the liquid sumps, which for 500,000 tonnes per annum of steel production equates to about 0.95 tonnes per minute and thereby ensuring operability of the desorber, continuity of flow of liquid metal as the dispersed phase and the availability of the full diffusional driving forces characteristic of non back-mixed gas/liquid contacting.

2. The method as claimed in Claim 1, wherein the liquid scrap is derived from solid steel scrap contaminated principally with zinc, copper and tin and also possibly other deleterious non-ferrous metal impurities.

3. The method as claimed in Claim 1, wherein the liquid scrap is derived from solid steel scrap contaminated with carbonaceous material either alone or in composite coatings comprised of organic coating in combination with zinc or other non-ferrous metal coating of such steel substrate material.

4. The method as claimed in Claim 1, wherein the liquid scrap is derived from solid steel scrap contaminated with unconsumed foodstuffs or other vegetable matter.

5. The method as claimed in Claim 1, wherein the liquid scrap is derived from steel contaminated with any one of the elements referred to in Claims 2, 3 and 4 is treated individually in isolation if sufficient quantities are available or alternatively, collectively together to save labour intensive and thus costly sorting.

6. The method as claimed in Claim 1, wherein the liquid scrap is formed continuously from solid contaminated steel scrap and then subsequently refined in a high temperature steelmaking circuit, the overall method comprising the steps of:-
(i) preheating the solid scrap in a protective gas atmosphere to separate out a molten zinc by-product prior to the scrap being assimilated into a forced-circulated stream of molten scrap (liquid scrap) within a closed-loop melt circulation system, fired on one side with combustion gases derived from natural gas or, alternatively, combustible process gases derived initially from carbothermic reduction of virgin iron ore material;
(ii) overflowing, withdrawing or siphoning out continuously the liquid scrap and incorporating it into a gas-lift pumping device which feeds the liquid scrap to the top of the first of two reduced pressure packed towers or similar devices, in which the liquid scrap is raised in temperature from near its liquidus temperature to a very much higher

temperature, possibly approaching the technical upper limit of available commercial refractories, by electrical conductive heating, before allowing it to irrigate the solid packing and flow downwards by gravity as rivulets or discrete droplets against an upward flow of strip gas at reduced pressure, which volatilizes elemental copper impurity dissolved in the liquid scrap, but only a relatively smaller amount of dissolved elemental tin, whilst itself becoming almost saturated with iron vapour;

(iii) withdrawing continuously via a barometric leg the now de-copperized liquid scrap into an atmospheric pressure sump and then into a second gas-lift pumping system employing a lift-gas to which elemental sulphur or gaseous sulphur or sulphur compound gas has been added to the extent that the liquid scrap absorbs sulphur so that greater than the stoichiometric requirement for all the dissolved tin to potentially form stannous sulphide is provided;

(iv) admitting the liquid scrap into the top of a second reduced pressure packed tower or similar device and using electrical conductive heating to increase the liquid scrap temperature up towards the service limit of suitable commercially available refractories prior to contacting the liquid scrap with an inert strip gas so that stannous sulphide is volatilized from the liquid scrap as it flows by gravity through the tower;

(v) withdrawing continuously via a barometric leg the now de-tinned and de-copperized liquid scrap into an atmospheric pressure sump, from which the non-ferrous metal depleted liquid scrap is overflown or siphoned continuously into an open-channel melt circulation loop in which low carbon steel is forced circulated at a rate many times that of the flow of the liquid scrap added to it, whilst the melt is desulphurized by addition of an appropriate flux or other established desulphurization means, and the carbon and oxygen contents adjusted to the required level, typically by carbon addition or CO_2/H_2O gaseous oxidation;

(vi) overflowing or siphoning out continuously refined low carbon steel to a continuous casting facility or, alternatively, interposing an additional in-line ultra-low carbon (ULC) refining step in advance of its transmission to a continuous casting facility.

7. The method as outlined in Claim 6 with additional special steps being taken to ameliorate evolution of carbon monoxide by establishing either or both low levels of dissolved carbon or oxygen before the liquid scrap referred to in Claim 1 and as claimed in any of the preceding claims, enters a reduced pressure desorber.

8. The method as outlined in Claim 6 for steel throughputs less than 0.5 Mtpa with decarburization and deoxidation to very low levels such as those associated with ultra low carbon steel (ULC) and deoxidation with metallic or alloy reagents before the liquid scrap referred to in Claim 1 and as claimed in any of the preceding claims, enters a reduced pressure desorber.

9. An alternative to the conductive heating method referred to in Claim 6 for preheating liquid scrap in advance of desorption of non-ferrous metals involving radiative heat transfer from an array of electrically heated graphite rods positioned above the incoming melt surface, provided the liquid scrap behaves essentially as a quiescent melt under the ambient operating pressure and dissolved carbon/oxygen levels.

10. The method as outlined in Claim 6 with additional features incorporated if the steel scrap charged to the process contains organic coated steel based on PVC or other sources of chlorine contamination, these features comprising contacting pyrolysis gases evolved during scrap preheating with a spray of liquid aluminium droplets followed then

by further contacting in a trickle irrigated packed bed employing a fused salt scrubbing medium containing sodium carbonate as the active ingredient.

11. The method as outlined in Claim 6 with the recirculated protective atmosphere being preheated at high intensity by the optional inclusion of a molten aluminium droplet contactor based on molten aluminium both as a heat transfer medium and chemical desiccant, utilizing electromagnetic melt circulation together with the commercially proven mechanical rotor/splash system developed originally as the condenser for the zinc blast furnace.

12. The method as outlined in Claim 6, wherein the exit desorber strip gas in advance of selective condensation of copper and then tin recovery and which is essentially saturated with iron vapour, is first subjected to direct contact iron condensation on recirculated liquid steel close to the liquidus temperature, employing residual unmelted steel shells for melt containment, stabilized by generation of high pressure steam by radiation from the outer surfaces of the retained solid steel shell, which surrounds an irrigated packed bed and its associated gas-lift liquid steel melt circulation system.